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Case ID:M21-201P^
Published: 10/17/2023

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Smart Environment-Aware Lower-Limb Robotic Prosthesis

Background

Robotic prostheses have the potential to change the lives of millions of lower-limb amputees by providing critical support during legged locomotion. Powered protheses specifically enable complex capabilities including level-ground walking, running, or stair climbing, while also enabling reductions in metabolic cost and improvements in ergonomic comfort. However, most existing devices are tuned toward and heavily focus on unobstructed level-ground walking, to the detriment of other gait modes, especially those required in dynamic environments.

Limitations to the range and adaptivity of gaits has negatively impacted the ability of amputees to navigate dynamic landscapes. The primary cause of falls is inadequate foot clearance during obstacle traversal. In many cases, only millimeters separate safe gaits from dangerous contact with the environment. Control solutions are needed to facilitate safe and healthy locomotion over common and frequent barriers such as curbs or stairs. One challenge that current intelligent prosthetics technology needs to overcome is the ability to sense and act upon important features in the environment.

Invention Description

Researchers at Arizona State University have developed a novel intelligent lower-limb robotic prosthesis system with a mounted camera to provide user protection against trips and falls. This technology provides additional control to the prosthesis to slightly pull up the foot when the user encounters stairs, curbs, and other obstacles. The camera collects RGB color information, and a depth estimation neural network is integrated into the embedded system, generating environment-aware control signals to the robotic prosthesis.

Potential Applications

- Robotic prosthesis applications (e.g., human-robot symbiotic walking)

Benefits & Advantages

- Helps users avoid dangerous contacts with the environment that can lead to trips and falls
- Ability to shape predictions and actions through visual features of the environment
- Efficient and real-time depth estimation
- Establishes clear segments where higher estimation precision is required (masks areas in which motion occurs)
- Reduces size, weight, and cost of necessary hardware

- Adds key features including close-range sensing, filtering, and temporal consistency

Related Publication: Predictive modeling of periodic behavior for human-robot symbiotic walking.